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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/053,085	11/09/2001	Raymond J. Gorte	PENN.N2437 C	5527

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HUNTON & WILLIAMS LLP  
INTELLECTUAL PROPERTY DEPARTMENT  
1900 K STREET, N.W.  
SUITE 1200  
WASHINGTON, DC 20006-1109

EXAMINER
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YUAN, DAH WEI D

ART UNIT	PAPER NUMBER
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1745

DATE MAILED: 05/11/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

AS

# Office Action Summary

Application No.

10/053,085

Applicant(s)

GORTE ET AL.

Examiner

Dah-Wei D. Yuan

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 02 February 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1-30 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-30 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 19 August 2002 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

## Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

## Attachment(s)

- |  |   |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892)   | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

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**THE USE OF SULFUR-CONTAINING FUELS FOR  
DIRECT OXIDATION FUEL CELLS**

Examiner: Yuan

S.N. 10/053,085

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May 6, 2004

***Continued Examination Under 37 CFR 1.114***

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on February 2, 2004 has been entered. Claims 31-53 were canceled. Claims 1,15-20 were amended.

2. The text of those sections of Title 35, U.S.C. code not included in this action can be found in the prior Office Action issued on November 3, 2003.

***Claim Rejections - 35 USC § 112***

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

4. Claims 1-30 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The phrase "[a] solid oxide fuel cell that can operate with a sulfur-containing hydrocarbon fuel that does not have to undergo prior treatment to remove organic sulfur compounds" in claims 1,20 is indefinite because the scope of "can operate" in describing the

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solid oxide fuel cell is unclear. Essentially, any solid oxide fuel cell should be able to operate with an untreated hydrocarbon fuel for an unspecified duration. Applicant is advised to clarify (or rewrite) the claimed subject matter.

***Claim Rejections - 35 USC § 103***

5. Claims 1-6,9-27,30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wallin (US 6,017,647) in view of Anumakonda et al. (US 6,221,280).

With respect to claim 1, Wallin teaches a solid oxide fuel cell comprising a electrolyte membrane of a ceramic oxygen ion conductor, a porous anode in contact with the electrolyte membrane on the fuel side of the cell, and a porous cathode in contact the electrolyte membrane on the oxidant side of the cell. The anode is typically a ceramic-metal composite. The net electrochemical reaction involves charge transfer steps that occur at the interface between the ionically conductive electrolyte membrane, the electronically-conductive electrode and the vapor phase. The vapor phase involves fuel for the anode and oxygen for the cathode. See Column 1, Lines 30-42.

However, Wallin does not disclose the characteristics of the fuel used for the aforementioned solid oxide fuel cell. Anumakonda et al. teach the use of sulfur-containing heavy hydrocarbon fuels for a solid oxide fuel cell. The hydrocarbon fuel is a liquid hydrocarbon having at least six carbon atoms and a sulfur content of at least 50 ppm. In one embodiment, the JP-8 fuel has a sulfur content of about 3000 ppm. The feed, containing the vaporized fuel and oxygen, is partially oxidized by a catalytic reaction to convert the

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hydrocarbon to hydrogen and carbon monoxide. As a result, the use of catalytic partial oxidation process to produce fuel enables a simplified overall system design. Furthermore, the product gas can be used as a fuel for a fuel cell system, either directly or after treatment for desulfurization. See Abstract, Column 1, Lines 11-15; Column 4, Lines 7-9,35-39, Column 8, Lines 36-42; Column 11, Lines 58-62. Therefore, it would have been obvious to one of ordinary skill in the art to use a fuel having sulfur content of at least 50 ppm to about 3000 ppm on the solid oxide fuel cell of Wallin, because Anumakonda et al. teach the processing and use of a sulfur-containing hydrocarbon fuel, such as JP-8, to simplify the overall design of a fuel cell system.

With respect to claims 2-6,9, Anumakonda et al. teach the conversion of refinery liquid hydrocarbon fuels, such as gasoline and naphtha, to hydrogen/carbon monoxide gas streams by partial oxidation process. The hydrocarbon fuels further comprises fuels, such as JP-4 jet fuel, JP-5 jet fuel, JP-8 jet fuel, No. 2 fuel oil, diesel oil, kerosene, and decane. See Column 2, Lines 6-18; Column 5, Lines 39-43; column 13, Lines 15-28. Therefore, it would have been obvious to one of ordinary skill in the art to use fuel, including jet fuel, gasoline, naphtha, fuel oil, diesel oil, kerosene, and decane, on the solid oxide fuel cell of Wallin, because Anumakonda et al. teach the processing and use of a sulfur-containing hydrocarbon fuel can simplify the overall design of a fuel cell system.

With respect to claims 10-14, Anumakonda et al. teach the military specification for maximum sulfur content in logistic fuels, such as Jet A, JP-4, JP-5, and JP-8, is 0.3 wt% (3000 ppm). Typically, however, commercially available jet fuels have a total sulfur content of about 0.05-0.07 wt.% (500-700 ppm). See Column 2, Lines 38-44. Therefore, it would have been

obvious to one of ordinary skill in the art to use a fuel having sulfur content of at about 500 to about 700 ppm on the solid oxide fuel cell of Wallin, because Anumakonda et al. teach the processing and use of a sulfur-containing hydrocarbon fuel, such as JP-4, JP-5, and JP-8, can simplify the overall design of a fuel cell system.

With respect to claim 15, Wallin discloses the electrolyte membrane is a ceramic oxygen ion conductor. See Column 1, Lines 30-32.

With respect to claims 16-19, Wallin teaches suitable ionically conductive materials include doped zirconia such as yttria-stabilized zirconia, scandium-doped zirconia, gadolinium-doped ceria, and rare earth or alkaline earth-doped  $\text{LaAGaO}_3$ . See Column 4, lines 49-59.

With respect to claim 20, Wallin teaches process to generate electrical energy by using a solid oxide fuel cell, which comprises a electrolyte membrane of a ceramic oxygen ion conductor, a porous anode in contact with the electrolyte membrane on the fuel side of the cell, and a porous cathode in contact the electrolyte membrane on the oxidant side of the cell. The anode is typically a ceramic-metal composite. The net electrochemical reaction involves charge transfer steps that occur at the interface between the ionically conductive electrolyte membrane, the electronically-conductive electrode and the vapor phase. The vapor phase involves fuel for the anode and oxygen for the cathode. See Column 1, Lines 30-42.

However, Wallin does not disclose the characteristics of the fuel used for the aforementioned solid oxide fuel cell. Anumakonda et al. teach the use of sulfur-containing heavy hydrocarbon fuels for a solid oxide fuel cell. The hydrocarbon fuel is a liquid hydrocarbon having at least six carbon atoms and a sulfur content of at least 50 ppm. In one

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embodiment, the JP-8 fuel has a sulfur content of about 3000 ppm. The feed, containing the vaporized fuel and oxygen, is partially oxidized by a catalytic reaction to convert the hydrocarbon to hydrogen and carbon monoxide. As a result, the use of catalytic partial oxidation process to produce fuel enables a simplified overall system design. Furthermore, the product gas can be used as a fuel for a fuel cell system, either directly or after treatment for desulfurization. See Abstract, Column 1, Lines 11-15; Column 4, Lines 7-9,35-39, Column 8, Lines 36-42; Column 11, Lines 58-62. Therefore, it would have been obvious to one of ordinary skill in the art to use a fuel having sulfur content of at least 50 ppm to about 3000 ppm on the process of Wallin, because Anumakonda et al. teach the processing and use of a sulfur-containing hydrocarbon fuel, such as JP-8, can simplify the overall design of a fuel cell system.

With respect to claims 21-27, Anumakonda et al. teach the conversion of refinery liquid hydrocarbon fuels, such as gasoline and naphtha, to hydrogen/carbon monoxide gas streams by partial oxidation process. The hydrocarbon fuels further comprises fuels, such as JP-4 jet fuel, JP-5 jet fuel, JP-8 jet fuel, No. 2 fuel oil, diesel oil, kerosene and decane. See Column 2, Lines 6-18; Column 9, Lines 1-4; column 13, Lines 15-28. Therefore, it would have been obvious to one of ordinary skill in the art to use fuel, including jet fuel, gasoline, naphtha, fuel oil, diesel oil, kerosene and decane, on the process of Wallin, because Anumakonda et al. teach the processing and use of a sulfur-containing hydrocarbon fuel can simplify the overall design of a fuel cell system.

With respect to claim 30, Anumakonda et al. teach the military specification for maximum sulfur content in logistic fuels, such as Jet A, JP-4, JP-5, and JP-8, is 0.3 wt% (3000

ppm). Typically, however, commercially available jet fuels have a total sulfur content of about 0.05-0.07 wt.% (500-700 ppm). See Column 2, Lines 38-44. Therefore, it would have been obvious to one of ordinary skill in the art to use a fuel having sulfur content of at about 500 to about 700 ppm on the process of Wallin, because Anumakonda et al. teach the processing and use of a sulfur-containing hydrocarbon fuel, such as JP-4, JP-5, and JP-8, can simplify the overall design of a fuel cell system.

6. Claims 1,2,7,8,20,28,29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wallin (US 6,017,647) in view of Fasano et al. (US 6,051,330).

With respect to claims 1,2,7,8, Wallin teaches a solid oxide fuel cell comprising a electrolyte membrane of a ceramic oxygen ion conductor, a porous anode in contact with the electrolyte membrane on the fuel side of the cell, and a porous cathode in contact the electrolyte membrane on the oxidant side of the cell. The anode is typically a ceramic-metal composite. The net electrochemical reaction involves charge transfer steps that occur at the interface between the ionically conductive electrolyte membrane, the electronically-conductive electrode and the vapor phase. The vapor phase involves fuel for the anode and oxygen for the cathode. See Column 1, Lines 30-42. However, Wallin does not disclose the characteristics of the fuel used for the aforementioned solid oxide fuel cell. Fasano et al. teach the use of light hydrocarbons, such as methane, propane, ethanol and methanol, as fuel for a solid oxide fuel cell because they produce less carbonaceous material build-up in the anode. The light hydrocarbons are used without any prior treatment to reduce the sulfur content. See Column 1, Lines 5-8, 61 to



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Column 2, Line 2. Fasano et al. do not specifically disclose the sulfur content in the fuel.

However, it is the position of the examiner that such characteristic is inherent, given that both Fasano et al. and the present application utilize similar alcohols, including methanol and ethanol.

A reference which is silent about a claimed invention's features is inherently anticipatory if the missing feature *is necessarily present in that which is described in the reference*. In re Robertson, 49 USPQ2d 1949 (1999). Therefore, it would have been obvious to one of ordinary skill in the art to use a light hydrocarbon fuel, such as methanol (or ethanol) having sulfur content from about 1 ppm to about 5000 ppm on the solid oxide fuel cell of Wallin, because Fasano et al. teach the use of a light hydrocarbon fuel can reduce the build-up of carbonaceous material in the anode of a solid oxide fuel cell. Alternatively, it would have been within the skill of the ordinary artisan to lower the production cost of alcohol by eliminating the desulfurization process because one of ordinary skill in the fuel cell art would recognize it is cost-effective to use alcohol having relative high sulfur content ( $> 1$  ppm) as fuel for a solid oxide fuel cell.

With respect to claims 20,28,29, Wallin teaches a process to generate electrical energy by using a solid oxide fuel cell, which comprises a electrolyte membrane of a ceramic oxygen ion conductor, a porous anode in contact with the electrolyte membrane on the fuel side of the cell, and a porous cathode in contact the electrolyte membrane on the oxidant side of the cell. The anode is typically a ceramic-metal composite. The net electrochemical reaction involves charge transfer steps that occur at the interface between the ionically conductive electrolyte membrane, the electronically-conductive electrode and the vapor phase. The vapor phase involves fuel for the anode and oxygen for the cathode. See Column 1, Lines 30-42.

However, Wallin does not disclose the characteristics of the fuel used for the aforementioned solid oxide fuel cell. Fasano et al. teach the use of light hydrocarbons, such as methane, propane, ethanol and methanol, as fuel for a solid oxide fuel cell because they produce less carbonaceous material build-up in the anode. See Column 1, Lines 5-8, 61 to Column 2, Line 2. Fasano et al. do not specifically disclose the sulfur content in the fuel. However, it is the position of the examiner that such characteristic is inherent, given that both Fasano et al. and the present application utilize similar alcohols, including methanol and ethanol. A reference which is silent about a claimed invention's features is inherently anticipatory if the missing feature *is necessarily present in that which is described in the reference*. In re Robertson, 49 USPQ2d 1949 (1999). Therefore, it would have been obvious to one of ordinary skill in the art to use a light hydrocarbon fuel, such as methanol having a sulfur content of from 1 ppm to about 5000 ppm on the process of Wallin, because Fasano et al. teach the use of a light hydrocarbon fuel can reduce the build-up of carbonaceous material in the anode of a solid oxide fuel cell. Alternatively, it would have been within the skill of the ordinary artisan to lower the production cost of alcohol by eliminating the desulfurization process because one of ordinary skill in the fuel cell art would recognize it is cost-effective to use alcohol having relative high sulfur content (> 1 ppm) as fuel in a fuel cell that produces electrical energy.

#### ***Response to Arguments***

7. Applicant's arguments filed on February 2, 2004 have been fully considered but they are not persuasive.

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*Applicant's principle arguments are*

*(a) Anumakonda et al. do not teach using a sulfur-containing hydrocarbon fuel as the fuel source for a solid oxide fuel cell;*

*(b) Fasano et al. teach away from using heavy hydrocarbons, like JP8 (see claims 3,4,22,23 of the instant application).*

In response to Applicant's arguments, please consider the following comments.

(a) Anumakonda et al. teach the use of a catalytic partial oxidation process to generate hydrogen and carbon monoxide from heavy hydrocarbon fuels containing a substantial amount of sulfur. The product gas can then be used directly in the fuel cell system without additional desulfurization treatment. See Column 8, Lines 30-47;

(b) in the most recent Action mailed on November 3, 2003, only claims 1,2,7,8,20,28,29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wallin in view of Fasano et al.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Dah-Wei D. Yuan whose telephone number is (571) 272-1295. The examiner can normally be reached on Monday-Friday (8:00-5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Patrick J. Ryan, can be reached on (571) 272-1292. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Dah-Wei D. Yuan  
May 6, 2004

A handwritten signature in cursive script, appearing to read "Dahwei Yuan", followed by a horizontal line.